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PATENT DISCLOSURE

Rev. O 5/31/95 SUBMITTED PURSUANT TO EMPLOYEE AGREEMENT

INTELLECTUAL PROPERTY DEPT. USE ONLY	
DISCLOSURE NO.	PT0334U
DATE	8/4/99
PATENT COMMITTEE ACTION	Prune 8/24

THIS SECTION TO BE COMPLETED BY INVENTOR(S)

1. Name of invention: (Limit to ten words.)
   Antenna System for a Wireless Data Tablet

2. Documentation Date: (Attach log sheets, drawings, etc., to support the earliest date you documented your idea.)
   13 January 1999; this is a resubmission of PT03283U.

3. Whom did you first tell about your invention? Name: **Kai Siwiak** Date: **12/98**

4. Is this disclosure being submitted as a Design disclosure? Yes___ No **X**
   If Yes, please attach a completed PPG DESIGN DISCLOSURE FORM along with this disclosure.

5. What problem is solved by this invention? (Attach additional sheets if necessary.)
   See attached sheets.

6. What is the closest known technology? (Attach additional sheets if necessary.)
   Diversity antenna schemes.

7. What is this invention? [AN ABSTRACT IS REQUIRED BELOW] Use additional sheets if necessary to describe how it resolves the problems in a new or novel way not accomplished by the closest known technology. **NOTE: If your invention doesn't accomplish something new, or in a novel way, then it is likely NOT patentable.**

   The invention is a switchable antenna system for a wireless data tablet. Multiple internal radiating elements are placed around the perimeter of the tablet, but only one is connected to the wireless transceiver at any given time. The choice of radiating elements is made by factors other than qualities of the RF communications link including, but not limited to, coordination with the display orientation; detection (by capacitance, luminance, or other means) of hand location; and the tablet's orientation in space. Based on these indications, the radiating element least likely to be covered by the hands, and most likely to be away from the body, is selected, for best radiating efficiency. See attached sheets.

THIS SECTION TO BE COMPLETED BY AN ENGINEERING OR PRODUCT MANAGER (or higher) ONLY

1. Product to be used in/on: (If a process, name the first product the process was/is to be used on.)
   none

2. Has/Is/Will this product been/being/be offered for sale? Have products incorporating this invention been described, quoted, or demonstrated to a customer? Have orders been accepted for the product? Explain the circumstances.)
   — *no* —

3. If item 2 is yes, when was/will the first offer for sale of a product incorporating this invention (be) made?
   Date:

4. When is the estimated ship date? *> 2001*

5. When was/will the first disclosure outside of Motorola (be) made? *> 2001*

6. How will the disclosure be made (state title and date of publication, if any) and to whom?
   Customer meeting

7. Was a non-disclosure agreement signed? Yes ___ Date: ___ No **X**

8. Engineering or Product Manager's Name (Type): *Clinton Powell* Phone: *x2014*

I attest to the accuracy of the above information.

Signature of Engineering or Product Manager (or higher): *[signature]* Date: *7/13/99*

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	DEPT. NO.	OFC. PHONE	PAGER	LOC. CODE	MAIL STOP	SHFT	EMPLOYEE STATUS (PERMANENT/CONTRACTOR)

INVENTOR: (LEGAL NAMES)
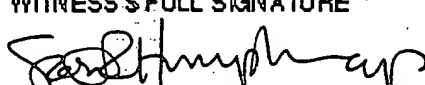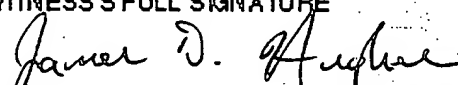
LAST (SURNAME)	FIRST	MIDDLE	SOCIAL SECURITY	IMMEDIATE SUPVR.

HOME ADDRESS:

STREET	CITY	STATE	ZIP	E-MAIL ID

CITIZENSHIP (I.E. U.S., GERMANY, ETC.)

	DEPT. NO.	OFC. PHONE	PAGER	LOC. CODE	MAIL STOP	SHFT	EMPLOYEE STATUS (PERMANENT/CONTRACTOR)

INVENTOR'S SIGNATURES:

INVENTOR'S FULL SIGNATURE	DATE
[signature]	13 July 1999
INVENTOR'S FULL SIGNATURE	DATE
INVENTOR'S FULL SIGNATURE	DATE

WITNESSES' NAMES AND SIGNATURES:

THE WITNESSES, IN SIGNING THIS FORM, ATTEST TO THE FACT THAT THEY UNDERSTAND THE INVENTION.

WITNESS'S FIRST/LAST NAME (TYPE)	PHONE	WITNESS'S FIRST/LAST NAME (TYPE)	PHONE
SCOTT R. HUMPHREYS	3838	James D. Hughes	3513

WITNESS'S FULL SIGNATURE	DATE	WITNESS'S FULL SIGNATURE	DATE
[signature]	13 JULY '99	*[signature]*	13 July 99

NOTE: BEFORE SUBMITTING, ALL BLANKS MUST BE COMPLETED AND ALL ADDITIONAL SHEETS MUST BE SIGNED, DATED, AND WITNESSED BY ALL INVENTORS AND TWO WITNESSES.

5. What problem is solved by this invention?

Wireless Information Tablets, such as the wireless web browsers WebPAD (http://www.cyrix.com/html/emerging/webpad/wp_bkgrd.htm), WebMan (http://www.anigma.com/webman.html), and Qubit (http://www.qubit.net), and the wireless electronic book under development by Nokia and SoftBook Press (http://www.softbookpress.com/softbook_sys/softbook.html), may be used in multiple orientations relative to the body. The tablet may be oriented in the so-called landscape format (short display side vertical), as one might do while web browsing or viewing slides, and then rotated to the so-called portrait format (long display side vertical), as one might do while reading email or an electronic book. For maximum reading flexibility, the non-wireless Rocket eBook electronic book from NuvoMedia allows the user to rotate the image in steps of ninety degrees so that, for example, the same side of the tablet may be held in either hand while reading (http://www.rocket-ebook.com/Products/Tour/index.html). Since antenna performance is greatly dependent on the antenna's physical relationship with the body, achieving consistent antenna performance under these conditions is difficult: No matter where the antenna is placed, it may end up under the user's hands, or pressed against the body, resulting in poor antenna performance.

One conventional approach to this problem is the use of antenna diversity -- choosing the best signal, or combination of signals, received from multiple antennas. One of the difficulties with this approach in portable products, getting enough space inside the product for the extra antennas, is less of a concern with wireless information tablets, due to their relatively large size. However, diversity also requires additional power for the duplicate receiver signal paths required, and this is very difficult to supply without significantly affecting product battery life. The duplicate receiver is also costly. There is also additional signal quality estimation that must be performed on the signal from each antenna, and the question of how to choose the proper transmit antenna. For these reasons antenna diversity is not a promising solution to this problem.

One is thus forced to accept either a reduction in wireless performance for some orientations, or the elimination of a feature users have come to expect -- the ability to orient the tablet in the most ergonomically pleasing way at any time.

What is desired is an antenna system that allows the user to orient the tablet relative to the body in any way desired, with consistent radiation performance.

7. What is the invention?

The invention is an antenna system consisting of multiple internal antennas, widely separated in the tablet (Fig. 1), and an RF switch connecting the antennas to the wireless transceiver and controlled by a signal from the tablet controller.
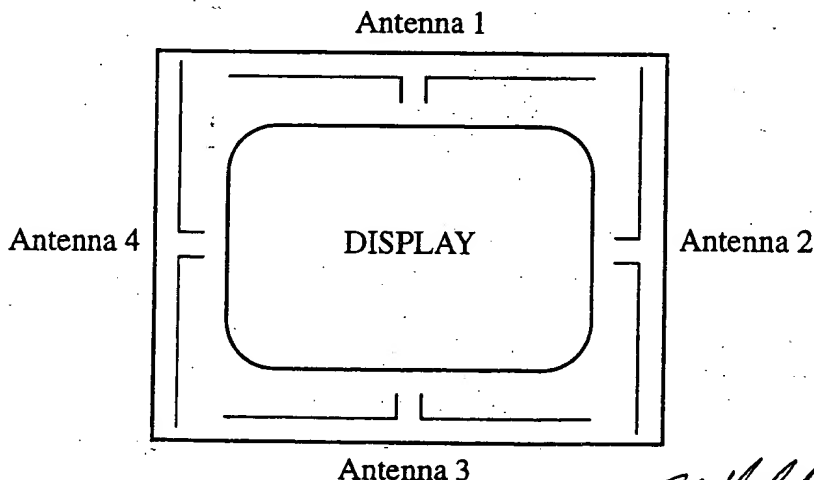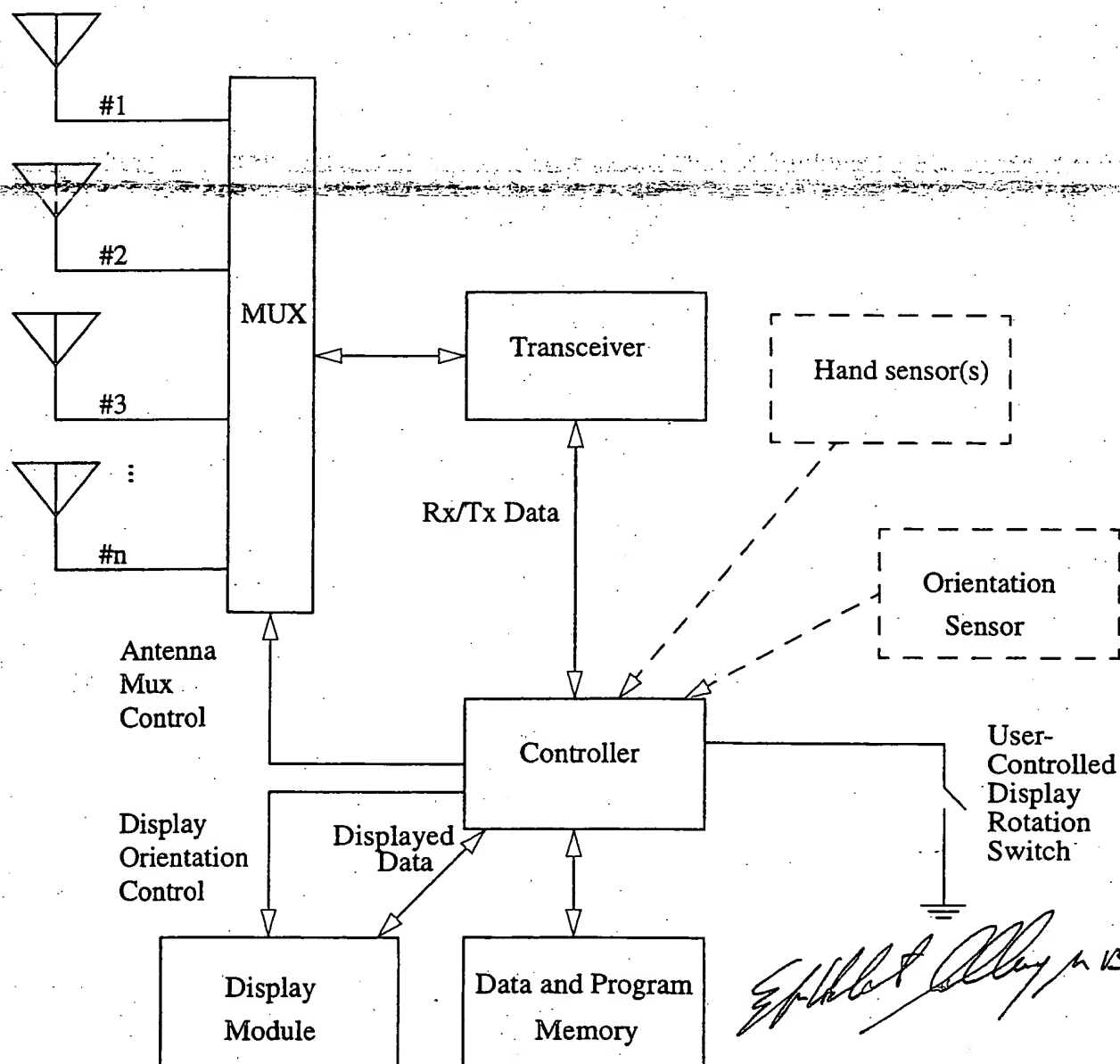
Antenna 1

Antenna 4   DISPLAY   Antenna 2

Antenna 3

Fig. 1: Location of antennas in disclosed invention.

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The tablet controller controls antenna switching based on factors other than qualities of the RF communications link, such as coordination with the display orientation (controlled by the user, either directly by special command [as in the Rocket eBook] or indirectly by the type of material displayed [web pages or text]); detection (by capacitance, luminance, or other means) of hand location; or the tablet's orientation in space (determined by mercury switches, for example).

A block diagram of the disclosed invention is shown in Fig. 6. The operation of the disclosed invention is as follows:

If the tablet coordinates antenna selection based on display orientation, the antenna at the top of the display is chosen, that being the antenna most likely to be free of the hands and away from the body.

Fig. 6.

If the tablet coordinates antenna selection based on hand detection, hand sensors (e.g., capacitive sensors or phototransistors) are placed near each antenna. The antenna with the sensor indicating the least obstruction (the lowest capacitance or the most light, relative to the other sensors in the tablet) is then chosen by the controller. An amount of hysteresis would, of course, be needed to control undesired switching between two antennas with similar sensor values.

If the tablet coordinates antenna selection based on the tablet's orientation in space, a gravity-sensitive detector (e.g., a set of mercury switches) is employed to determine the location of "up" and "down". The highest antenna (the one closest to "up") is then chosen. An amount of hysteresis would, of course, be needed to control unnecessary switching between two antennas in certain orientations (e.g., when the tablet is lying flat on a table).

The controller may, of course, combine methods. For example, it may use the display orientation method to make a decision if the spatial orientation method provides indeterminate results (e.g., when the tablet is lying flat on a table).

The user may, through a "preferences" entry, modify the above antenna selection criteria to cover special circumstances. For example, the user may wish to modify the hand detection algorithm under unusual lighting conditions, if the phototransistor method of hand detection is used.

13 July '99

James D. Hughes   13 July 99

13 July 1999